

FY99 - Innovative Vacuum Electronics MURI

94GHz Slotted Sixth-Harmonic Gyrotron - UC-Davis



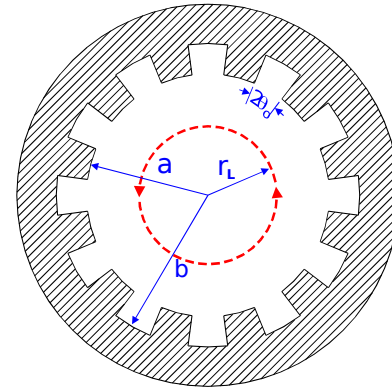
Objectives

Basic research to reduce magnetic fields needed by 94 GHz gyrotrons to make HPM devices lighter

Investigate concept of 25-100 kW W-band high harmonic gyrotron

Basis for high-harmonic gyro-amplifiers

12-Vane Slotted Circuit



Approach

Operation at s^{th} -harmonic reduces magnetic field by factor of s

Cusp gun produces needed axis-encircling electron beam

Slotted circuit enhances interaction

Accomplishments

Received two Northrop Cusp guns

94 GHz 6th-harmonic gyrotron concept

- 50 kW with 20% efficiency
- Circuit has been fabricated

94 GHz 8th-harmonic gyrotron concept

- Employs permanent magnet

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Photo-Electron Emission from Si Field Emitters - UC



Objectives

- Basic research on high speed optically gated field emission.

Investigate concepts for

robust

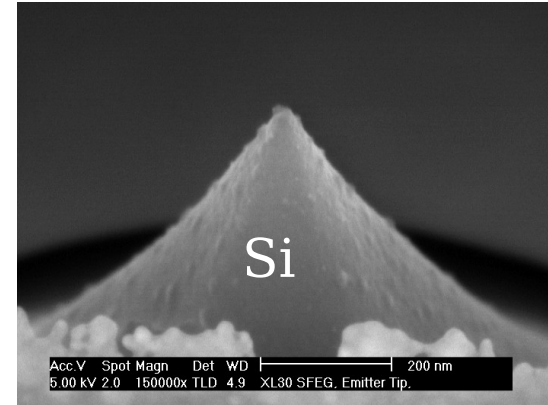
Approach

pulsed vacuum photo-Fabricate Si field emitter arrays cathode.

Subpicosecond optical excitation.

Characterize field penetration depth with doping level.

Ultrasharp Si Field Emitter T



Accomplishments

Fabricated 100 x 100 gated array.

15 nm tip radius with 1 micron gate radius.

Measured CW L-I curves.



MIT PHOTONIC BANDGAP CAVITY RESEARCH

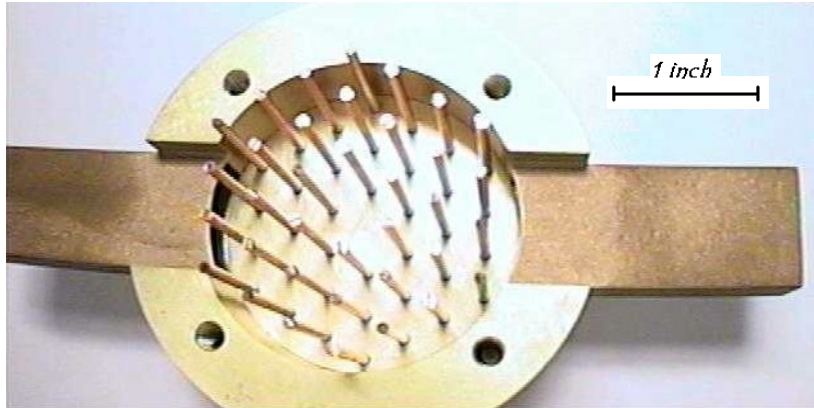
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Started 1 May 99

Massachusetts Institute of Technology

<http://www.psfc.mit.edu/wab/personnel/temkin.html>

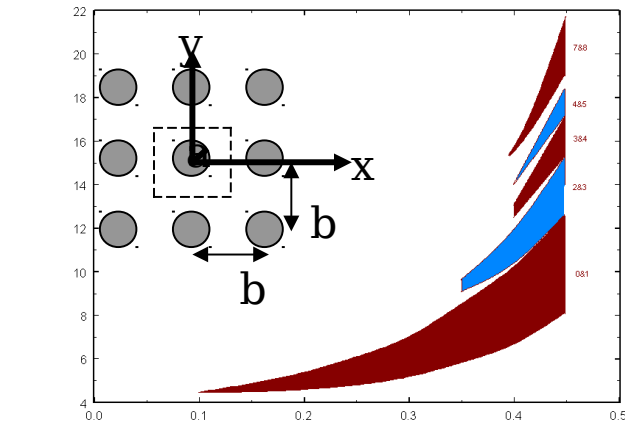
August, 2000



Photonic Bandgap Cavity

Accomplishments (Experiment)

- PBG cavity studied in cold test
- 17 GHz frequency, TM_{010} -like mode
- Triangular lattice of metal rods with a defect in the center
- Waveguide coupling, some rods removed or partially withdrawn for coupling



Normalized frequency b/c

Lattice aspect ratio
(rod radius a)/(spacing b)

Accomplishments (Theory)

- PBGSS - Photonic Bandgap Structure Simulator - code developed for metal rod lattices
- Global bandgaps in square lattices determined



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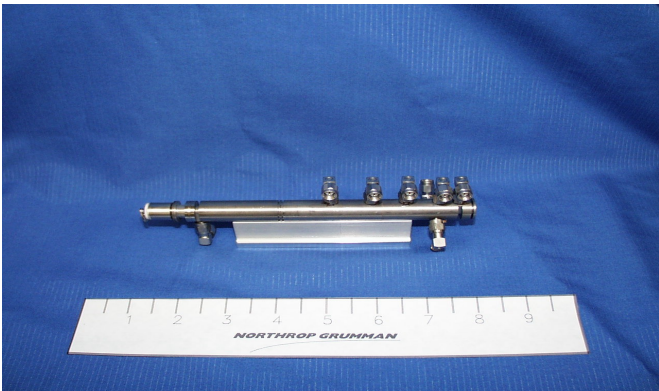
University of Wisconsin

Web URL:<http://tempest.engr.ucdavis.edu/muri99/muri99.html>



Started 1 August 99

Aug '99 - July



Custom-designed research TWT with unprecedented experimental access to detailed internal physics including a multiple-output-port circuit and spent beam diagnostic access

Scientific/technical approaches

- Establish state-of-the-art TWT research capabilities
- Establish fundamental understanding of nonlinear TWT physics
- Investigate strategies to maximize linearity at high efficiency

• Leverage capabilities with

MURI Objectives^{'00}

- Investigate traveling wave tube (TWT) performance for broadband amplification (including impulse & multitone) with high power, efficiency, and linearity
(**impact: advanced ECM**)
- Identify physics for TWT amplification of digital high-data-rate signals with high efficiency and preserved signal integrity
(**impact: high-speed wireless comm & datalinks**)

Most Significant Accomplishments

- Successful creation of a unique fundamental research TWT device(w/ Northrop Grumman)
- Formulation of new TWT theoretical models (w/ U Michigan).



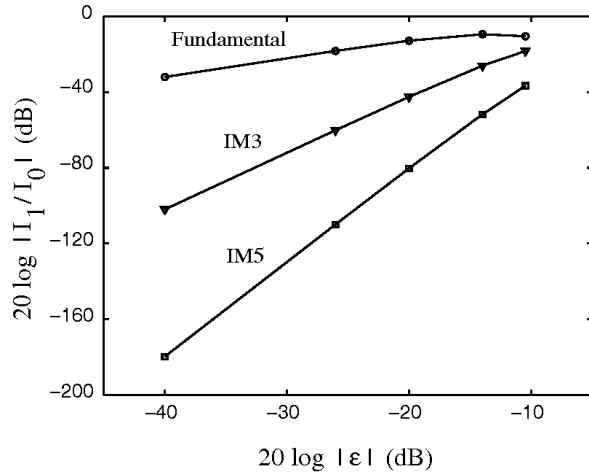
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MURI, year started: 99

University of Michigan

Date



MURI Objectives

- Understand interference in DoD microwave sources
- Explore reduction of interference & noise

Scientific/technical approaches

- Theory: both analytic and computational techniques
- Experiment: signal

Accomplishments

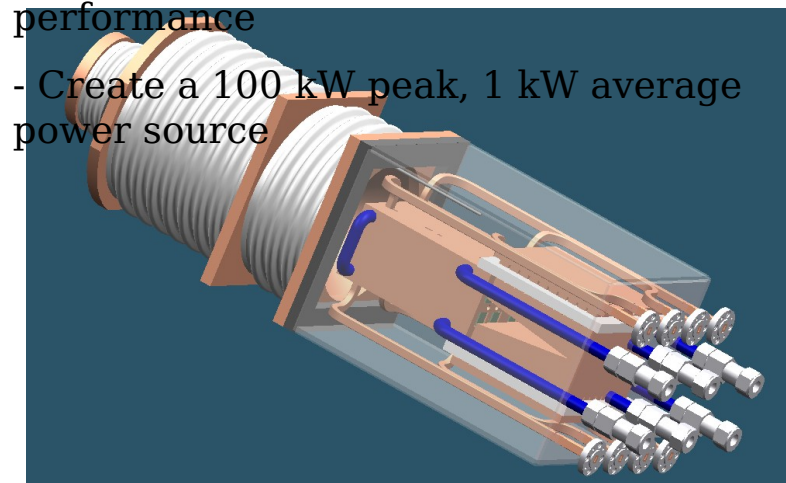
- Breakthrough in klystron intermodulation theory
- UW Collaboration on TWTT

UC Davis/Stanford Collaboration on High-Average-Power Modular W-band

Klystrons

Klystron Research Program

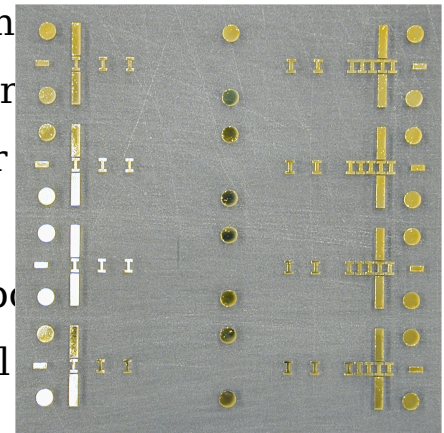
- Investigate high average power klystron at W-band
- Explore alternative fabrication methods to provide efficient, modular, and cost effective RF source
- Improve modeling of three dimensional RF circuit
- Diagnose e gun and beam transport performance



Model of four klystrino

module

Four “klystrinos” on 6 cm by 6 cm substrate. Round posts are for circuit alignment. Short rectangular posts are for beam tunnel alignment.



Six cavity klystrino circuit prior to electrodeposition

Project Status

LIGA fabrication of W-band cavities produced intrinsic Q's near theoretical values

Beamstick with six cm PPM circuit produced >95% transmission

MAFIA and MAGIC used to produce accurate 2 D model of 3-D klystrino circuit

Machining of the electrodeposited LIGA

Coherent MM-Wave



UC Davis